

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

FRESHWATER TRICLADS (TURBELLARIA) OF
NORTH AMERICA.

III. *SPHALLOPLANA WEINGARTNERI* NEW SPECIES,
FROM A CAVE IN INDIANA.¹

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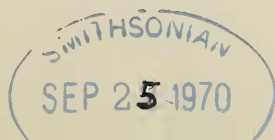
Freshwater triclads or planarians represent important components of the subterranean aquatic fauna. The various species are generally found in very limited geographic areas, confined to individual cave systems. This geographic isolation has led to a high degree of speciation as is the case also with other true troglobites (see de Beauchamp, 1932; Hyman, 1960; Nicholas, 1960).

So far no obligate troglobitic planarian is known to occur in Indiana caves. *Phagocata subterranea* Hyman, a white and sometimes eyeless planarian reported from Donaldson's Cave in Spring Mill State Park near Mitchell, Lawrence County (Hyman, 1937: 474), proved to be a hypogean form of *P. gracilis* (Haldeman), a species widely distributed in surface waters. Professor Eliot C. Williams of Wabash College found in specimens from Donaldson's Cave "all gradations in pigmentation between light and almost black and similar variation in eyes" (personal communication).

On 15 August 1969, Mr. Lawrence Weingartner collected a sample of planarians in Bronson's Cave, also in Spring Mill State Park, and sent them to me alive. Bronson's Cave belongs to the same cave complex as Donaldson's Cave and is traversed

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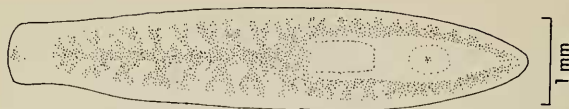


FIG. 1. *Sphalloplana weingartneri*, sketch of gliding animal, from life.

by the same stream. The sample contained several specimens of the light-colored subterranean form of *Phagocata gracilis* and one blind planarian which, upon anatomical investigation, turned out to be a new species of *Sphalloplana*.

***Sphalloplana weingartneri* new species**

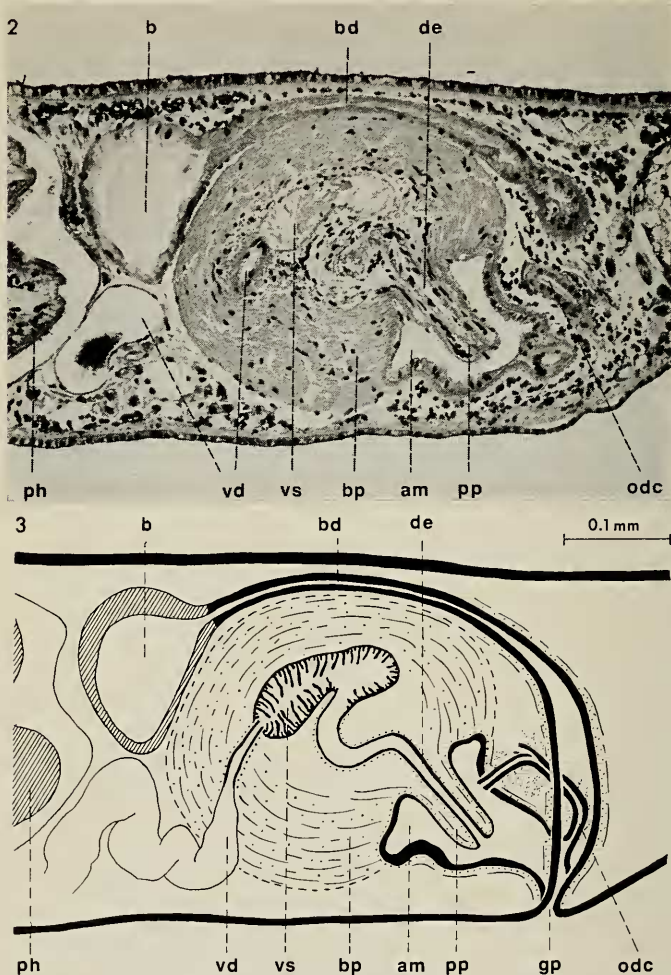
External features (Fig. 1): Only one specimen, sexually mature, was at my disposal. This is a rather small unpigmented, white species, in life 6 mm long and 1.2 mm wide. The body is almost transparent, with some of the internal organs clearly discernible. The anterior end is truncate, with convex frontal margin and rounded side (auricular) edges which do not protrude laterally. Therefore, there is no constriction or "neck" seen behind the head region. The lateral margins gradually widen in the anterior half of the body, then soon converge again to form a rather rounded posterior end. The specimen is eyeless, blind. Behind the middle of the frontal margin an opaque spot indicates the location of the adhesive organ. A certain distance behind the front end the intestinal system begins, extending over the entire area of the body except the head, a broad border along the lateral margins, and the area of the copulatory complex. There are 9 or 10 ramified lateral branches on the anterior ramus of the intestine and more numerous shorter branches on each of the two posterior rami. The pharynx is inserted somewhat behind the middle of the body and is rather short, its length being about one-seventh the length of the body. In the postpharyngeal region the copulatory apparatus is seen as a round, transparent field in the center of which there is an opaque spot.

Surface epithelium: The epithelial covering of the body shows some modifications on the body margins. Along the lateral border is a strip of very tall cells containing rhabdites much longer than those of either the dorsal or the ventral surface. This strip is underlain by masses of rhabdite-forming glands in the neighboring mesenchyme. Adjoining this strip on the ventral side is the submarginal zone of adhesive gland openings. Both the thickened epithelial border and the adhesive gland zone reach anteriorly to about the lateral edges of the frontal margin of the head. Along the frontal margin the epithelium is of normal thickness, free of rhabdites, and heavily ciliated, which probably represents the auricular sense organs usually occurring in this location.

Adhesive organ: This organ, very characteristic of the genus *Sphalloplana* (including *Speophila*), is developed in the new species in the typical way. The anatomy of the adhesive apparatus has been discussed by Hyman (1937 and 1954) and in greater detail by Mitchell (1968: 611–613). From these descriptions it becomes clear that the shape of the organ as it appears in preserved and sectioned material is subject to great variation, depending on the state of contraction or protrusion at the moment of killing. In our specimen the organ is retracted, forming an invagination of irregular outline. The cells of the epithelium lining its cavity are engorged with a granular, eosinophilic secretion. They are approached by many gland outlets the cell bodies of which are scattered in the mesenchyme of the anterior half of the prepharyngeal region, both above and below the intestinal branches. Tinctorially the secretion of these glands differs from that of the submarginal adhesive zone, as they assume a deeper, somewhat bluish hue after staining with Eosin Y-Phloxine B. Attached to the glandular epithelium are many muscle fibers originating from the subepidermal muscle layers principally of the dorsal side, which function as retractors of the organ. Extension of the adhesive organ (which I have not observed in life) is probably accomplished by a contraction of the integumental muscles of the head region which increases the internal turgor of the head and pushes the inverted epithelium forward. Actually the subepidermal muscle layers at the level of the organ are markedly thickened, measuring in thickness $16\ \mu$ to $31\ \mu$ dorsally and $15\ \mu$ ventrally (at the level of the pharynx, the corresponding thicknesses are $9\ \mu$ and $9\ \mu$, respectively). The fibers most prominently developed seem to run in a transversal ("circular") direction, although it is not possible to make a precise analysis of the integumental muscle layers on sagittal sections. It is known that the structure of these layers may be quite complex (see Graff, 1912–17: 2745–2746); in our case, the predominant fibers may belong to the circular or diagonal layers. This will have to be checked on tangential sections of the head region.

Reproductive system: The ovaries are located, as typical, on the medial sides of the ventral nerve cords, at a level behind the first or second lateral branch of the anterior intestinal ramus. No parovaria are developed. The vitellaria or yolk glands are not fully differentiated and are represented by strands of large cells with cyanophilic cytoplasm branching off from the oviducts dorsally and laterally. The testes are numerous and occupy two broad bands, one on each side of the midline, extending from the level of the ovaries to about the root of the pharynx. They are situated in both the dorsal and ventral parts of the mesenchyme, the dorsal position slightly prevailing. Individual large testes may bridge the entire depth of the body from the dorsal to the ventral subepidermal muscle layers.

The copulatory apparatus (Fig. 2 and 3) conforms with the design of the genus *Sphalloplana*. The genital aperture or gonopore (*gp*) leads



FIGS. 2-3. *Sphalloplana weingartneri*, copulatory apparatus. 1. Photomicrograph of sagittal section. 2. Semidiagrammatic view of sagittal section. *am*, male atrium; *b*, copulatory bursa; *bd*, bursa duct; *bp*, penis bulb; *de*, ejaculatory duct; *gp*, genital aperture; *odc*, common oviduct; *ph*, pharynx; *pp*, penis papilla; *vd*, vas deferens; *vs*, seminal vesicle.

anteriorly into a relatively small male atrium (*am*) and dorsally and somewhat to the left into the end portion of the bursa duct (*bd*). The atrium is lined with a cuboidal epithelium underlain by two layers of muscle fibers, a circular and a longitudinal one. No common genital

atrium is developed. The penis consists of a large, spherical bulb (*bp*) and a rather small cylindrical or finger-shaped papilla (*pp*) protruding into the atrium. The bulb is very muscular, containing fibers which are arranged in more or less concentric layers. It encloses an elongated cavity, the seminal vesicle (*vs*), the wall of which is formed by cells projecting villuslike into the lumen and apparently having a glandular (apocrine) function. From this vesicle extends a narrow canal which, after some initial convolution, enters the penial papilla and opens at its tip, the ejaculatory duct (*de*). This canal is surrounded by a layer of circular muscle fibers. The two sperm ducts or vasa deferentia (*vd*), which at the level of the pharynx have enlarged to form the usual false seminal vesicles (spermiducal vesicles according to Hyman's, 1951, terminology), enter the penis bulb ventrolaterally. They proceed toward the seminal vesicle, each narrowing to a short canal with a coat of circular muscles, and open into the anterior part of the vesicle in close proximity to each other. The penis papilla (*pp*) is covered by a flattened epithelium with the usual two underlying muscle layers, a circular and a longitudinal one.

The two oviducts, which in the anterior part of the body have run along the upper side of the ventral nerve cords, ascend in the region of the copulatory complex, approach the midline, the left one passing through the space between the atrial wall and the bursa duct (*bd*), and unite above the male atrium. The common oviduct (*odc*) thus formed curves ventrally and opens into the posterior part of the atrium. The paired oviducts after they have left the nerve cords and the common oviduct receive numerous gland ducts with eosinophilic secretion, the so-called shell glands.

The copulatory bursa (*b*) is a smooth rounded sac lying dorsally between the pharyngeal pouch and the bulb of the penis. Its outlet, the bursal stalk or duct (*bd*), runs posteriorly above the penis bulb and behind this curves ventrally and somewhat to the left of the midline to open to the outside at the gonopore (*gp*). The anterior part of the duct is rather narrow and seems to be devoid of the muscle layers usually present in other planarian species. Behind the penis, the bursa duct widens and acquires two muscular coats of circular and longitudinal fibers. This terminal part, clearly differentiated from the anterior portion, may be termed a vagina.

The paucity of mesenchymal glands connected with the copulatory apparatus is remarkable. Only the shell glands emptying into the oviducts could be identified. On the other hand, some of the epithelia lining the various cavities are definitely of a glandular nature, such as the walls of the seminal vesicle, of the bursa duct, and of the copulatory bursa.

Distribution: The only specimen was collected in Bronson's Cave, Spring Mill State Park, Lawrence County, Indiana. It was taken 50–70 m inside the cave in the company of more common light-colored specimens of *Phagocata gracilis*. The collector informs me that the planarians occurred in a section of the cave which has a rich fauna of both epigeal and true

troglolithic species, probably as a result of both animals and food being washed in through the stream which enters the cave from above ground.

Taxonomic position: There is always a certain risk involved in describing a new planarian species on the basis of the study of one single specimen. The copulatory complex, which furnishes the most important features characterizing the individual species, is subject to great variation in the shape of muscular organs capable of contraction, extension, and distortion. Thus, the configuration of the penis, the size relation between its bulb and papilla, and other dimensional relations vary considerably depending on the method used in killing the animal, on the phase of its maturity, and possibly even on the physiological condition of the specimen. Considering these handicaps I may stress that my specimen was well-preserved as to its shape and histology. It had been killed in a saturated aqueous solution of corrosive sublimate (HgCl_2) applied hot and later acidulated with acetic acid. The sections were stained with Ehrlich's hematoxylin and Eosin Y-Phloxine B. At most there may be a certain longitudinal contraction in the area of the copulatory complex, judging from the unusual curvature of the ejaculatory duct and the shortness of the penis papilla.

The genus *Sphalloplana* was established by de Beauchamp (1931: 321) for *Dendrocoelum percoecum* Packard (1879). In a later paper, Hyman (1937: 462) described and defined a related genus, *Speophila*, differing from *Sphalloplana* in the anatomy of the adhesive organ. Subsequently (Hyman, 1945: 481), as she studied additional species of the two genera, she expressed the opinion that probably all gradations in the development of the adhesive organ will be found and that *Speophila* may be, in the future, considered a synonym of *Sphalloplana*. This step was finally taken by Mitchell (1968: 613-615) and seconded by Kawakatsu (1969: 45). I fully agree with their conclusions in this matter.

The genus *Sphalloplana* consists at present of about 19 species some of which may be placed in synonymy by future investigators. They are found generally in subterranean waters and in springs, chiefly in North America (16 species), eastern Asia, and Siberia. *Sphalloplana weingartneri* differs from the other species of the genus mainly in the anatomy of its copulatory apparatus. The most outstanding characteristic is the excessive development of the penis bulb and the reduction in size of the penis papilla. Although the shape of the penis and size proportions of bulb and papilla may present variable aspects in preserved specimens as a result of muscular contraction, the spherical shape of the bulb appears to be its natural condition in life, corresponding to the circular field seen in the postpharyngeal region of the living animal (Fig. 1). Other peculiarities concern the clear histological differentiation of the penis lumen into a seminal vesicle and an ejaculatory duct, and the modification of the terminal part of the duct of the copulatory bursa as a vagina, without the presence of a pronounced sphincter in this area. There is a superficial resemblance between the anatomical features of the copulatory complex of

S. weingartneri and those of *S. pricei* Hyman (1937). Apart from the difference in the size of the two species (*S. weingartneri*, 6 mm long in life, 4 mm after preservation; *S. pricei*, up to 15 mm long in the preserved state), which by itself is not a significant distinction, details in gross morphology and histology of the copulatory organs clearly separate the species. I have compared the slides of Hyman's type specimen of *S. pricei* (U.S. National Museum 20228) and sections of three topotypic specimens (Refton Cave, Lancaster County, Pennsylvania, USNM 36121) with *S. weingartneri* and have noticed the following distinctive characters: In *S. pricei* the penis papilla is larger, conical, rather plump, and apparently very pliable judging from the various distorted shapes and constrictions it shows in different specimens. The two vasa deferentia, which enter the bulb from the ventrolateral sides, unite within the bulb; the common vas deferens thus formed opens into a wider cavity, the seminal vesicle, from which a canal, the ejaculatory duct proceeds to the blunt tip of the papilla. There is no histological distinction between the epithelia of the seminal vesicle and the ejaculatory duct.

Type material: *Sphalloplana weingartneri*, holotype, set of two slides of sagittal sections, U.S. National Museum No. 41181.

Acknowledgment: The new species is named in honor of Mr. Lawrence Weingartner (now at Michigan State University) who kindly furnished the specimen on which the present description is based.

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